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IV. *An Account of a very uncommon Darkneſs in the States of* New-England, *May* 19, 1780. *By* SAMUEL WILLIAMS, *A. M. Hollis Profeſſor of Mathematics and Philoſophy in the Univerſity at* Cambridge.

THE beſt method to promote the knowledge and ſcience of nature, is to proceed by way of obſervation and experiment. The general courſe, productions, and laws of nature, ſhould be carefully and ſteadily attended to: and when any new phenomena appear, all the circumſtances and effects, relating to them, ſhould be particularly noted and collected. In this way we ſhall be moſt likely to arrive at the knowledge of their cauſes: or, at leaſt, we ſhall prepare thoſe materials which may enable poſterity to determine, with certainty and preciſion, on what at preſent may be but imperfectly underſtood.

With this view, I ſhall endeavour to lay before the Society, as particular an account as I can collect, of the uncommon darkneſs which took place in the ſtates of *New-England*.

The *time* of this extraordinary darkneſs, was May 19, 1780. It came on between the hours of ten and eleven, A. M. and continued until the middle of the next night; but with different appearances at different places. As to the *manner* of its approach it ſeemed to appear firſt of all in the S. W. The wind came from that quarter, and the darkneſs appeared to come on with the clouds that came in that direction. The *degree* to which the darkneſs aroſe, was different in different places. In moſt parts of the country it was ſo great, that people were unable to read common print—determine the time of day by their clocks,

clocks or watches—dine—or manage their domeſtic buſineſs, without the light of candles. In ſome places, the darkneſs was ſo great, that perſons could not ſee to read common print in the open air, for ſeveral hours together: but I believe this was not generally the caſe. The *extent* of this darkneſs was very remarkable. Our intelligence, in this reſpect, is not ſo particular as I could wiſh: but from the accounts that have been received, it ſeems to have extended all over the *New-England* ſtates. It was obſerved as far eaſt as *Falmouth*.—To the weſtward, we hear of its reaching to the furtheſt parts of *Connecticut*, and *Albany*.—To the ſouthward, it was obſerved all along the ſea-coaſts:—and to the north, as far as our ſettlements extend. It is probable it extended much beyond theſe limits, in ſome directions: but the exact boundaries cannot be aſcertained by any obſervations that I have been able to collect. With regard to its *duration*, it continued in this place at leaſt fourteen hours: but it is probable this was not exactly the ſame in different parts of the country. The *appearance* and *effects* were ſuch as tended to make the proſpect extremely dull and gloomy. Candles were lighted up in the houſes;—the birds having ſung their evening ſongs, diſappeared, and became ſilent;—the fowls retired to rooſt;—the cocks were crowing all around, as at break of day;—objects could not be diſtinguiſhed but at a very little diſtance; and every thing bore the appearance and gloom of night.

Such were the general appearances or phenomena of this extraordinary darkneſs. I ſhall now mention ſuch particular obſervations as I have been able to collect, which were either made on this phenomenon, or ſeem to relate to it.

With regard to the ſtate of the atmoſphere preceding this uncommon darkneſs, it was univerſally obſerved for ſeveral days before, that the air appeared to be full of ſmoke and vapour. The ſun and the moon appeared remarkably red in their colour, and diveſted of their brightneſs and lucid appearance: and this obſcuration increaſed as they approached nearer to the horizon. This was obſerved to be the caſe in almoſt all parts of the *New-England* ſtates, for four or five days preceding the 19th of May. The winds had been variable; but chiefly from the S. W. and N. E. The thermometer from 40° to 55°. The barometer rather high for this part of *America*,—from 29 inches 80, to 30 inches 50. The weather had been fair and cool for the ſeaſon.

As to the ſtate of the atmoſphere when the darkneſs came on, it was obſervable, that the weight or gravity of it was gradually decreaſing the bigger part of the day. This may be inferred from the obſervations that were made in this place by the Rev. Profeſſor *Wiggleſworth*, and Mr. *Gannett*. At $12^{h.}$ they found the mercury in the barometer ſtood at 29 inches 70. At $12^{h.}\,30'$, the mercury had fallen the $\frac{1}{100}$ part of an inch. At $1^{h.}$ it was at 29 inches 67. At $3^{h.}$ it was at 29 inches 65. At $8^{h.}\,8'$ it was at 29 inches 64. I made a courſe of barometrical obſervations ſimilar to theſe, at the ſame time, in a different part of the ſtate. I was then at *Bradford*, about thirty miles north of this place, nearly under the ſame meridian, or rather a little to the eaſt. At $6^{h.}$ A. M. I found the mercury in the barometer 29 inches 82. As ſoon as the darkneſs began to appear uncommon, I obſerved the barometer again, and found the mercury at 29 inches 68: this was at $10^{h.}\,20'$. At $10^{h.}\,45'$, the darkneſs aroſe to its greateſt degree in that part of the country; and the mercury was then at 29 inches 67. The darkneſs continued in the ſame degree for an hour and an half. At 12$^{h.}$ 15′, the mercury had fallen to 29 inches 65; and in a few minutes after this, the darkneſs began to abate. The mercury remained in this ſtate until evening, without any ſenſible alteration. At 8$^{h.}$ 30′, it ſeemed to have fallen a little; but ſo ſmall was the alteration, that it was attended with ſome uncertainty; nor could I preceive that it ſtood any lower at 11$^{h.}$ 30′.

Both theſe barometers appear to be very good inſtruments. That uſed in this place was made by *Champney*: that which I uſed was made by *Nairne*: and they may both be depended on as to the accuracy of their conſtruction. It may, however, be proper to obſerve, that the houſe where I made my obſervations, ſtood at leaſt forty or fifty feet higher than that in which the obſervations were made here.

And from theſe obſervations it is certain, that on the day when the darkneſs took place, the weight or gravity of the atmoſphere was gradually decreaſing through the whole day.*

The colour of objects that day, was alſo worthy of remark. It is mentioned, in the obſervations made by the gentlemen here, that "the complexion of the clouds was compounded of a faint red, yellow, and brown: and that, during the darkneſs, objects, which commonly appear green, were of the deepeſt green, verging to blue; and that thoſe which appear white, were highly tinged with yellow." Much the ſame obſervation was pretty generally made. Almoſt every object appeared to me to be tinged with yellow rather than with any other colour. This I found to be the caſe with every thing I held up to view, whether near, or remote from the eye.

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* *Farenheit's* thermometer, at *Bradford*, at 6^{h}. A. M. was at 39°. At 12^{h}. it ſtood at 51°. At 9^{h}. P. M. it was at 46.—At *Cambridge*, at 12^{h}. it was at 51½°. At 3^{h}. P. M. it ſtood at 51°.

Another thing that deſerves our attention is, the nature and appearance of the vapours that were then in the atmoſphere. Early in the morning, the weather was cloudy: the ſun was but juſt viſible through the clouds, and appeared of a deep red, as it had for ſeveral days before. In moſt places thunder was heard ſeveral times in the morning. The clouds ſoon began to riſe from the S. W. with a gentle breeze; and there were ſeveral ſmall ſhowers before eight o'clock: and in ſome places there were ſhowers at other times, throughout the day. The water that fell was found to have an uncommon appearance, being thick, dark and ſooty. A gentleman, who was then at *Ipſwich*, obſerves, that "he found the people much ſurprized with the ſtrange appearance and ſmell of the rain-water which they had ſaved in tubs. Upon examining the water, I found (ſays he) a light ſcum over it, which rubbing between my thumb and finger, I found to be nothing but the black aſhes of burnt leaves: the water gave the ſame ſtrong ſooty ſmell which we had obſerved in the air." The ſame appearance was obſerved in many other places: and it was very remarkable on *Merrimack-River*. Large quantities of ſcum, or black aſhes, were found floating upon the ſurface of the water, that day. In the night, the wind veered round to the N. E. and drove it towards the ſouth ſhore. When the tide fell, it lay along the ſhore at the width of four or five inches. This I found to be the caſe for five or ſix miles;—and probably it was the caſe for many more. I examined a conſiderable quantity of this matter; and in taſte, colour and ſmell, it very plainly appeared to be nothing more than what the gentleman obſerved at *Ipſ-*

wich,—the black aſhes of burnt leaves, without any ſulphureous, or other mixtures.*

Being apprehenſive whether there was not ſome uncommon matter in the air that day, I put out ſeveral ſheets of clean paper in the air and rain. When they had been out four or five hours, I dried them by the fire. They were much ſullied, and became dark in their colour; and felt as if they had been rubbed with oil or greaſe. But upon burning them, there was not any appearance of ſulphureous or nitrous particles.

The motion and ſituation of the vapours in the atmoſphere, was alſo worthy of notice. In moſt places it was very evident that the vapours were deſcending from the higher parts of the atmoſphere towards the ſurface of the earth. A gentleman, who was then at *Pepperrell,*† mentions a very curious obſervation, as to their *aſcent* and *ſituation.* "About nine o'clock (ſays he) in the morning, after a ſhower, the vapours roſe from the ſprings in the low lands, in great abundance. I took notice of one large column that aſcended with great rapidity, to a conſiderable height above the higheſt hills, and ſoon ſpread into a large cloud; then moved off a little to the weſtward. A ſecond cloud was formed in the ſame manner, from the ſame ſprings, but did not aſcend ſo high as the firſt: and a third was formed from the ſame places, in leſs than a quarter of an hour after the ſecond. About three quarters of an hour after nine o'clock, theſe clouds exhibited a very romantic appearance. The upper cloud appeared of a *rediſh* colour: the ſecond appeared,

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* The ſame was obſerved at *Concord* and *Dover* in *New-Hampſhire*: at *Berwick,* and many other places in this ſtate.

† Mr. *Eames,* a Tutor in the Univerſity.

peared, in ſome places, *green*; in others, *blue*; and in others, of an *indigo* colour: the third cloud appeared almoſt *white*." One of the gentlemen who obſerved here, mentions a circumſtance of ſomewhat a ſingular nature.—" While the darkneſs continued (ſays he) the clouds were in quick motion, interrupted, ſkirted one over another; ſo as apparently, and I ſuppoſe, really, to form a conſiderable number of *ſtrata*: the lower *ſtratum* of an uniform height as far as viſible;—that height conceived to be very ſmall from the ſmall extent of the viſible horizon, and from this circumſtance obſerved in the evening:—Being in the ſtreet, I ſaw a perſon with a lighted torch, which occaſioned a reflection of a faint red light, ſimilar to a faint Aurora Borealis, at a ſmall height above my head. The height at which the reflection appeared to be made, was not more than from twenty to thirty feet."—And it was generally remarked, that the hills might be ſeen at a diſtance in ſome directions, while the intermediate ſpaces were greatly obſcured and darkened.

From theſe obſervations, it ſeems as if the vapours, in ſome places, were aſcending; in moſt, deſcending; and in all, very near to the ſurface of the earth. To this we may add, that during the darkneſs, objects appeared to caſt a ſhade in every direction: and that, in many places, there were ſeveral appearances or corruſcations in the atmoſphere, not unlike the *Aurora Borealis*: but I do not find that there were any uncommon appearances of the electric fire any where obſerved that day.*

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* In ſeveral accounts it was alſo mentioned, that a number of ſmall birds were found ſuffocated by the vapour. " A number were found dead in ſeveral of the new towns, round the houſes; and ſome flew into the houſes, as I have been told by eye-witneſſes." Extract of a letter from *Dover*, in *New-Hampſhire*.

Having mentioned the phenomena, with ſuch obſervations upon them, as I have been able to collect, I ſhall now endeavour to account for the cauſe of this unuſual appearance.

From the obſervations that have been mentioned, we may conclude with much certainty, that the atmoſphere, on the 19th of May, was charged with an uncommon quantity of vapour. That this was the caſe, is evident from the large quantity of ſmoke and vapour that appeared in the atmoſphere for ſeveral days before; which was ſo great, as to darken the ſun and moon, and render all objects, at a diſtance, of a dull and very hazy appearance. It was alſo evident, from the deſcent of thoſe large quantities of ſoot, or black aſhes, which, through a long extent of country, were found mingled with the rain that fell, and floating on the ſurface of the waters. And the cauſe from whence the uncommon quantity of theſe vapours was derived, is eaſily aſcertained. It is well known, that in this part of *America*, it is cuſtomary to make large fires in the woods, for the purpoſe of clearing the lands in the new ſettlements. This was the caſe this ſpring, in a much greater degree than is common. In the county of *York*, in the weſtern parts of the ſtate of *New-Hampſhire*, in the weſtern parts of this ſtate, and in *Vermont*, uncommonly large and extenſive fires had been kept up. The people in the new towns had been employed in clearing up their lands this way, for two or three weeks before: and ſome large and extenſive fires had raged in the woods for ſeveral days before they could be extinguiſhed. In addition, therefore, to what ariſes from evaporation, and thoſe exhalations which are conſtant and natural, a much larger quantity of vapour aroſe from thoſe large and numerous fires, which extended all around our frontiers. As the weather had been clear, the air heavy, and the winds ſmall and variable for ſeveral days; the vapours, inſtead of diſperſing, muſt have been riſing and conſtantly collecting in the air, until the atmoſphere became highly charged with an uncommon quantity of them.

A large quantity of the vapours, thus collected in the atmoſphere, on the 19th of May, were floating near the ſurface of the earth. Whereſoever the ſpecific gravity of any vapour is leſs than the ſpecific gravity of the air, by the laws of fluids, ſuch a vapour will aſcend in the air. Where the ſpecific gravity of a vapour, in the atmoſphere, is greater than that of the air, ſuch a vapour will deſcend: and where the ſpecific gravity of the vapour and air are the ſame, the vapour will then be at reſt,—floating or ſwimming in the atmoſphere, without aſcending or deſcending. From the barometrical obſervations it appears, that the weight or gravity of the atmoſphere was gradually growing leſs, from the morning of the 19th of May, until the evening. And hence the vapours, in moſt places, were deſcending from the higher parts of the atmoſphere, towards the ſurface of the earth. From the obſervation made at *Pepperrell*, it appears, that in ſome places the vapours were aſcending, until they aroſe to an height in which the air was of the ſame ſpecific gravity; where they inſtantly ſpread, and floated in the atmoſphere:—and this height was not much above the adjacent hills. From theſe obſervations, we are lead to conclude, that the place where the vapours were balanced, or became of the ſame ſpecific gravity as the air, muſt have been very near the ſurface of the earth. And hence we may obſerve,

That ſuch a large quantity of vapour, floating in the atmoſphere, near the ſurface of the earth, might be ſufficient to produce all the phenomena that were obſerved May 19, 1780.—Thus the *direction* in which the darkneſs came on, would be determined by the direction of the wind; which accordingly was obſerved to be from the S. W. The *degree* of the darkneſs would depend on the denſity, colour, and ſituation of the clouds and vapour; and the manner in which they would tranſmit, reflect, refract, or abſorb the rays of light. The *extent* of the darkneſs would be as great as the extent of the vapour: and the *duration* of it would continue until the gravity of the air became ſo altered, that the vapours would change their ſituation, by an aſcent or deſcent. All which particulars will, I think, be found to agree very exactly with the obſervations that have been mentioned. Nor does the *effect* of the vapours, in darkening terreſtrial objects, when they lay near the ſurface of the earth, appear to have been greater than it was in darkening the ſun and moon, when their ſituation was higher in the atmoſphere.

Upon the whole, it is evident, that the atmoſphere was charged, in a high degree, with vapours; and that theſe vapours were of different denſities, and occupied different heights. By this means the rays of light falling upon them, muſt have ſuffered a variety of refractions and reflections; and thereby become weakened, abſorbed, or ſo far reflected, as not to fall upon objects on the earth in the uſual manner. And as the different vapours were adapted by their nature, ſituation, or denſity, to abſorb, or tranſmit, the different kind of rays, ſo the colours of objects would appear to be affected by the mixture and prevalency of thoſe rays that were tranſmitted through ſo uncommon a medium.

In what has been ſaid, I have endeavoured to explain what I take to be the cauſe of the late unuſual darkneſs. I would not, however, be underſtood to aſſert, that there could not be any other cauſes or circumſtances which might join to produce this unuſual appearance. Poſſibly there might be cauſes and circumſtances of this nature, of which we have no ſuſpicion. But as the uncommon quantity and ſituation of the vapours in the atmoſphere might be ſufficient to account for the phenomena, it appears to me to be unneceſſary to look out for other cauſes, or to go into a particular examination of the various conjectures that have been advanced upon this ſubject.

It may not be amiſs to obſerve, that ſuch appearances, and from the ſame cauſe, have been obſerved before, in this part of *America*. In the Philoſophical Tranſactions, N°· 423, there is an account of a remarkable darkneſs, which took place October 21, 1716, O. S. It is ſaid, " The day was ſo dark, that people were forced to light candles to eat their dinners by. Which could not be from any eclipſe, the ſolar eclipſe being the 4th of that month." This obſervation was made by Mr. *Robie*, a man of great ingenuity, and formerly a Tutor in the Unverſity : but there is nothing ſaid as to the cauſe, or any other particulars. Several perſons have informed me, that they remember an uncommon darkneſs in the year 1732, Auguſt 9, O. S. and which was afterwards found to be occaſioned by an uncommon fire in *Canada*. It is to be wiſhed, that we could find ſomething more particular upon this ſubject.

There was alſo a remarkable darkneſs at *Detroit*, October 19, 1762, much like that of May 19 ; of which we have this account, by the Rev. *James Stirling*, Phil. Tranſ. for 1763, vol. liii. p. 63. " Tueſday laſt, being the 19th inſt. (i. e. of

" October) we had almoſt total darkneſs for the moſt of the " day. I got up at day break. About ten minutes after, I ob- " ſerved it got no lighter than before. The ſame darkneſs con- " tinued until nine o'clock, when it cleared up a little. We " then, for the ſpace of about a quarter of an hour, ſaw the " body of the ſun, which appeared as red as blood, and more " than three times as large as uſual. The air, all this time, " which was very denſe, was of a dirty yellowiſh colour. I " was obliged to light candles to ſee to dine, at one o'clock, " notwithſtanding the table was placed cloſe by two large win- " dows. About three, the darkneſs became more horrible; " which augmented until half paſt three, when the wind breez- " ed up from the S. W. and brought on ſome drops of rain, " or rather ſulphur, and dirt; for it appeared more like the " latter than the former, both in ſmell and quality. I took a " leaf of clean paper, and held it out in the rain, which ren- " dered it black whenever the drops fell upon it; but, when " held near the fire, turned to a yellow colour; and when " burned, it fizzed on the paper like wet powder. During this " ſhower, the air was almoſt ſuffocating with a ſtrong ſulphu- " reous ſmell.—It cleared up a little after the rain.

" There were various conjectures about the cauſe of this na- " tural incident. The *Indians*, and vulgar among the *French*, " ſaid, that the *Engliſh*, which lately arrived from *Niagara* in " the veſſel, had brought the plague with them. Others ima- " gined, it might have been occaſioned by the burning of the " woods: but I think it moſt probable, that it might have " been occaſioned by the eruption of ſome volcano, or ſubter- " raneous fire, whereby the ſulphureous matter may have been " emitted in the air, and contained therein, until, meeting with

" ſome watery clouds, it has fallen down together with the " rain."

We have another account of this phenomena, in a letter from an officer, who was then at *Detroit*, to a friend at *Wilmington*, in *Pennſylvania*. " The 19th of this month, (October, 1762) " was the moſt extraordinary dark day, perhaps, ever ſeen in " the world. At nine in the morning, it was ſcarce lighter " than at break of day, and ſo continued till about twelve " o'clock,—the air being very full of ſmoke, accompanied with " a ſtrong ſmell, as of wood, ſtraw, and other combuſtibles, " when burning. At half an hour after one, it was ſo dark " that we were obliged to light candles to dine by. At this " time it rained a little; with which fell a quantity of black " particles, like aſhes, as turned every thing it fell upon black. " Even the river (which is twice as wide as *Chriſtiana* in *Penn-* " *ſylvania*) was covered with black froth; which, when ſcumm- " ed off the ſurface, reſembled the lather of ſoap, with this " difference, that it was (and as black as ink) more greaſy. At " ſeven in the evening, the air was more clear, and the diſagree- " able ſmell was now almoſt gone. We have ſince been in- " formed, by people who were twenty miles from hence that " day, that the darkneſs, rain, and ſmell, was the ſame with " them."

There does not appear to have been any thing to ſupport the conjecture of a *volcano*, *ſubterraneous fires*, and *ſulphureous matter*. In all other particulars, the phenomena agree to thoſe that were obſerved among us, and ſeem to be derived from the ſame cauſe.

Felix, qui potuit rerum cognoſcere cauſas,
Atque metus omnes et inexorabile fatum
Subjecit pedibus.——————